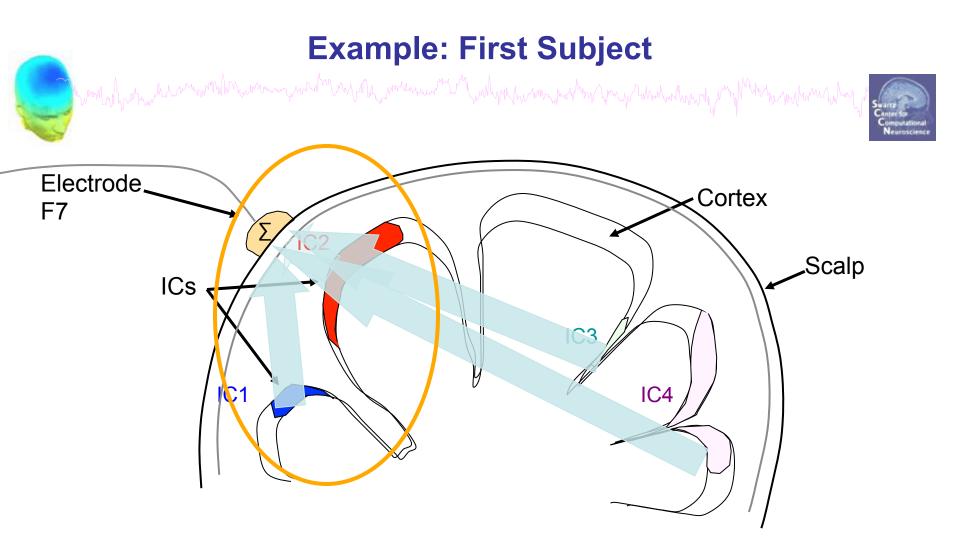
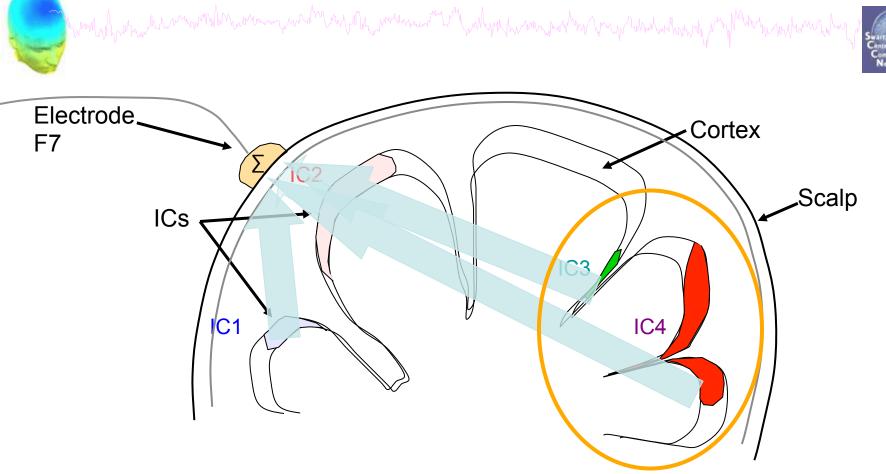
Why cluster independent components across subjects or sessions?



- ICA transforms the data from a channel basis (activity recorded at each channel)
 - to a component basis (activity computed at each IC).
- Normally, EEG researchers assume that electrode, say channel F7 == F7 == F7 ... in each subject and then 'cluster' their data channel by channel ...
- But this is only *roughly* correct!



Second Subject

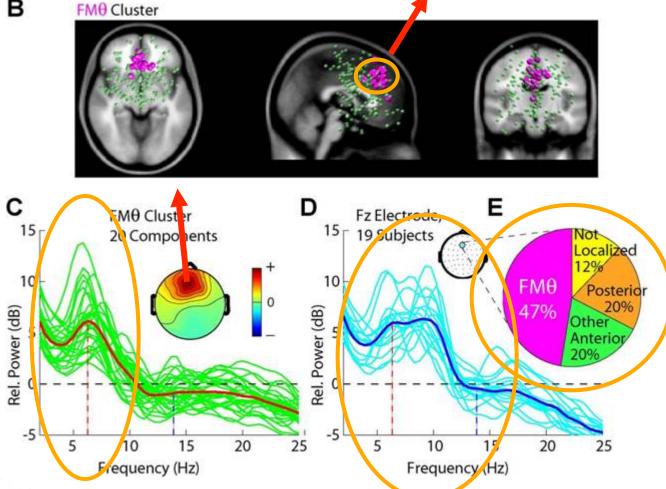


Makeig, 2005

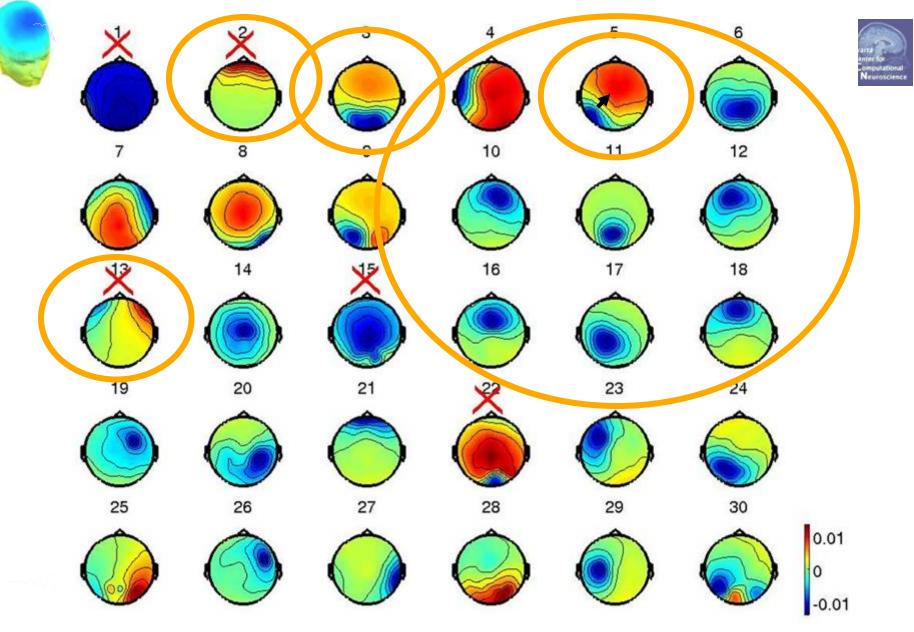
A FM-theta cluster during working memory



в



Largest 30 independent components (single subject)



Makeig, 2007

So how to cluster components?

when the war and the second and the second with the second and the second and the second production of the second second



The same problems hold for clustering independent components

Across Ss, components don't even have "the same" scalp maps!

 \rightarrow Are "the same" components found across subjects?

- What should define "the same" (i.e., "component equivalence")?
 - Similar scalp maps?
 - Similar cortical or 3-D equivalent dipole locations?
 - Similar activity power spectra?
 - Similar ERPs?
 - Similar ERSPs?
 - Similar ITCs?
 - OR ..., Similar combinations of the above?? ...





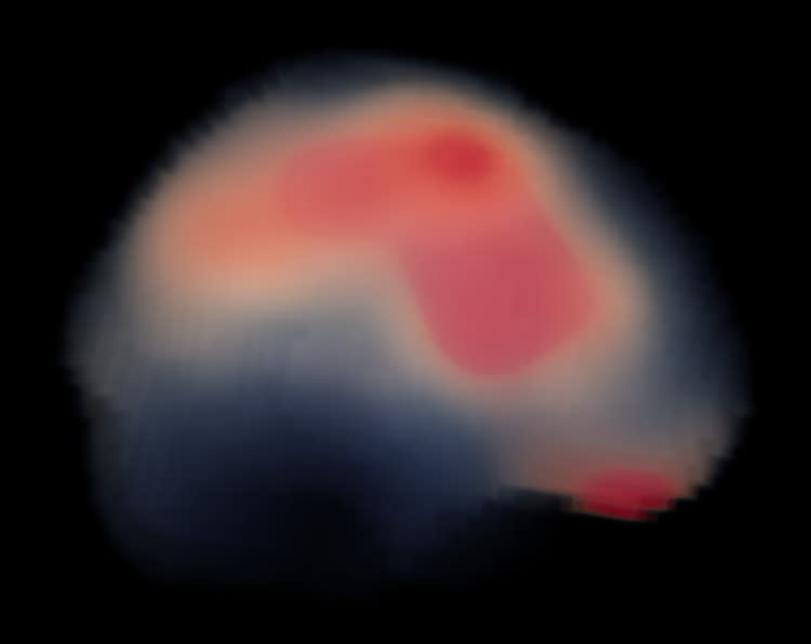
Does the spatial distribution of ICs depend on the task the subject performs?

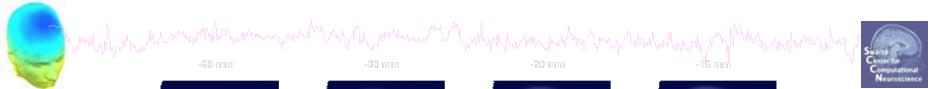
i.e.

Do "the same" ICs (and IC clusters) appear for every task?



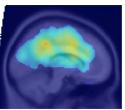
Makeig, 2007



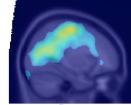




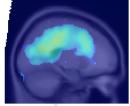
-10 mm



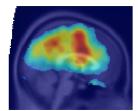
10 mm



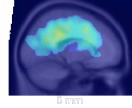
-5 mm

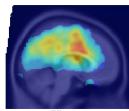


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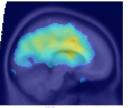


20 mm

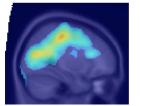


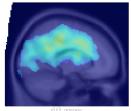


25 mm

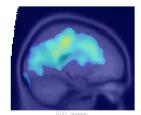


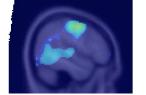
30 mm

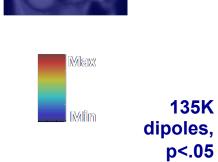




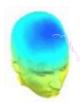
40 mm





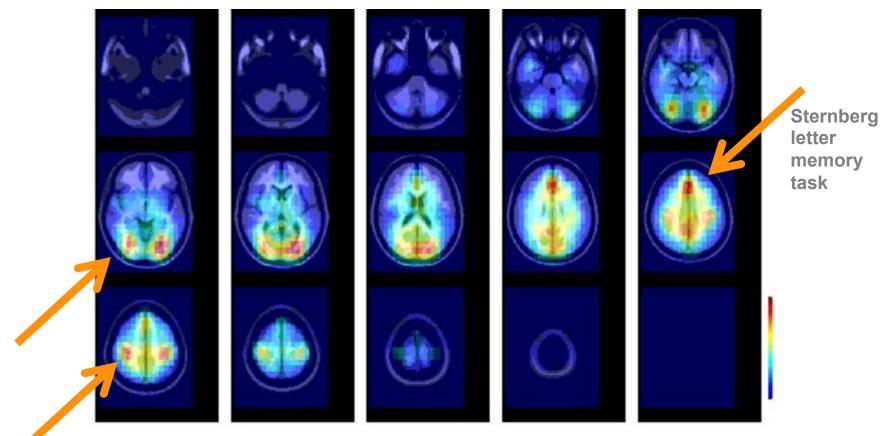


EEGLAB Workshop 16, June, 2013, Aspet, France: Scott Makeig – Component Clustering



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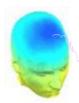




>> dipoledensity()

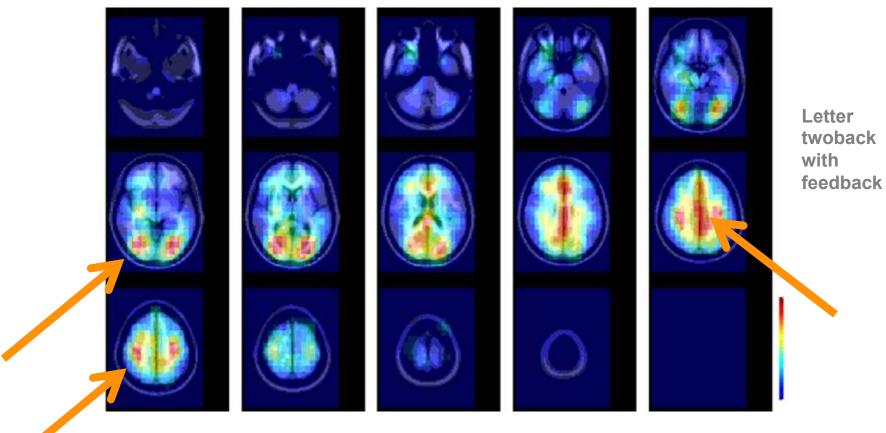
Onton et al., 2

Onton et al., '05



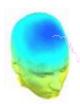
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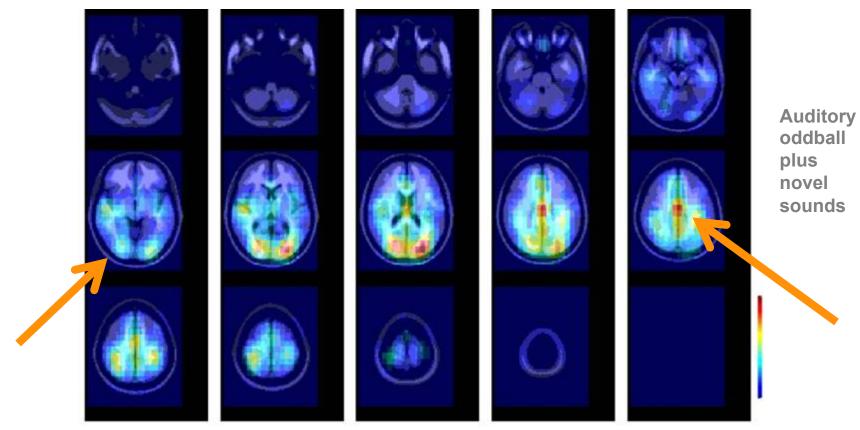
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Onton et al., 2



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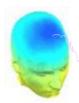




>> dipoledensity()

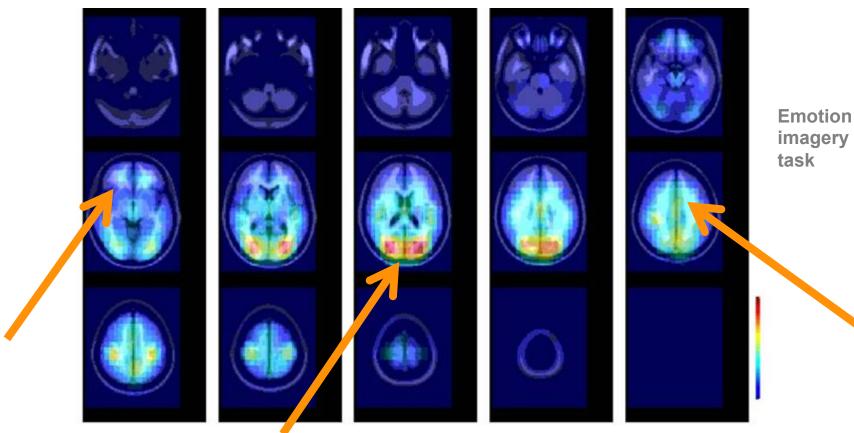
Onton et al., 2

Onton et al., '05



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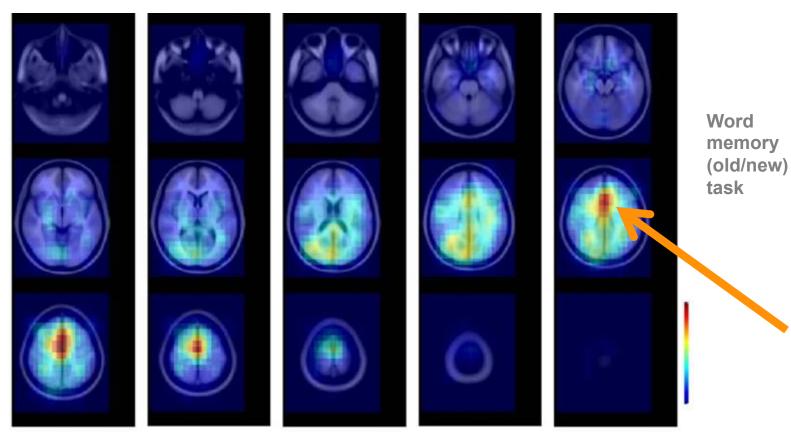
>> dipoledensity()

Equivalent dipole density Exp I



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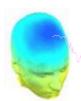


>> dipoledensity()

Onton et al., 2

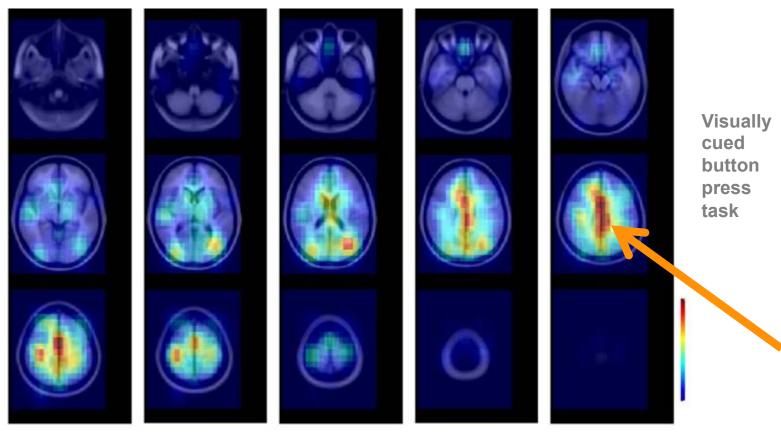
Onton et al., '05

Equivalent dipole density Exp II



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>> dipoledensity()

Onton et al., 2

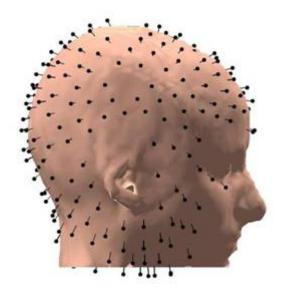
Onton et al., '05

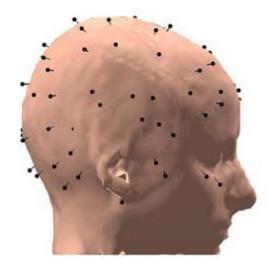
... Some caveats

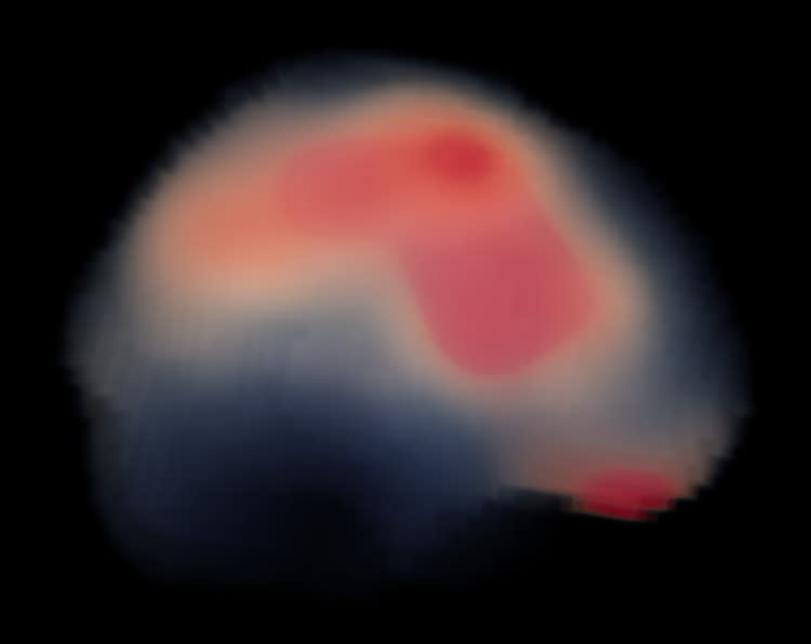
Swante Center for Computational Neuroscience

In this preliminary *dipoledensity()* study ...

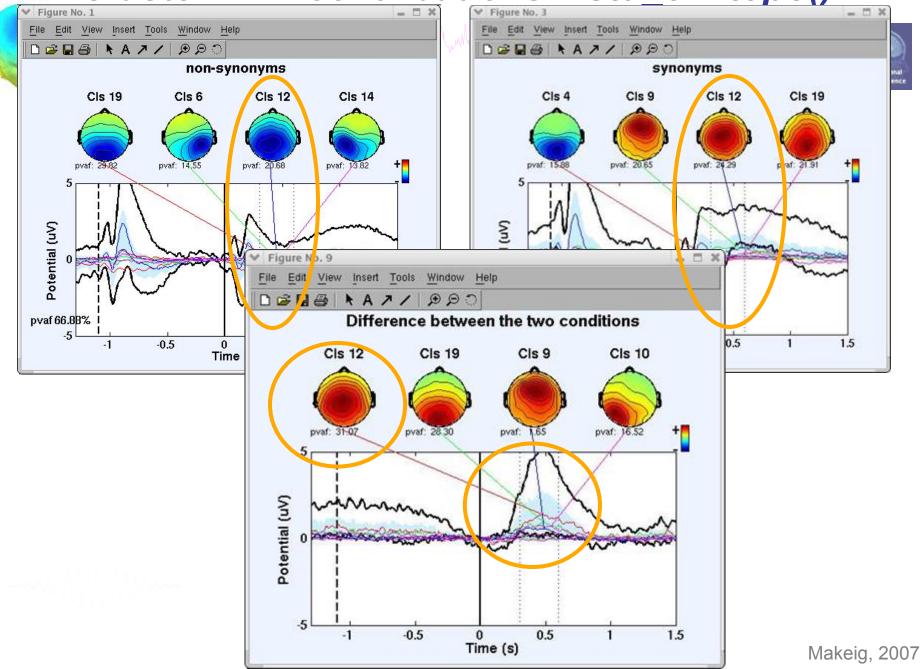
- The electrode locations were not individualized.
- MR images were not available \rightarrow co-registration crude.
- Single versus dual-dipole model selection was subjective.
- Different electrode montages \rightarrow possible location effects







Cluster ERP contributions – std_envtopo()



Should all subjects be included in each cluster?

Not all subjects contribute components to each cluster.

Why not?

- Different numbers of artifact components
- Subject differences!?
- Is my subject group really just a Gaussian cloud

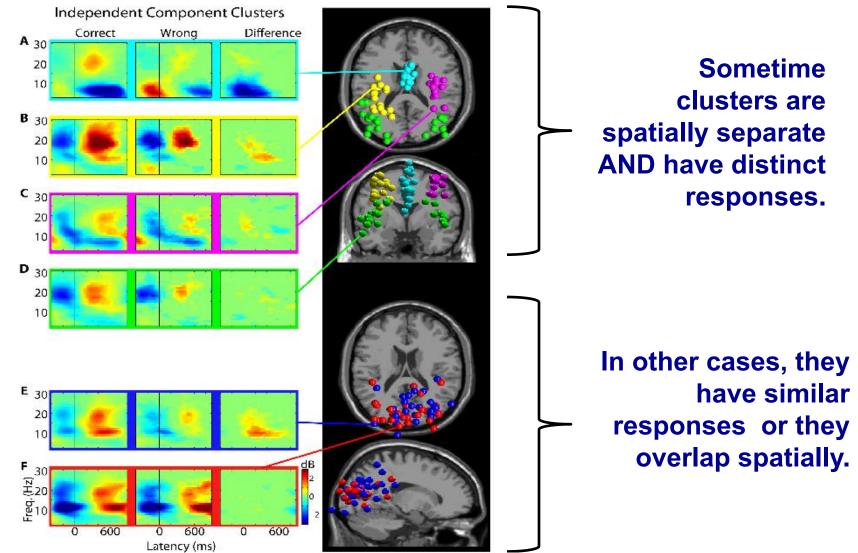
in 'subject space'??



Study IC Clustering







Onton & Makeig, 2007



Large parameter space problem: many different clustering solutions can be produced by changing parameters and measure subsets. Which one should we choose?

EEGLAB clustering has ~12 parameters



Select and compute component measures for later clustering pop_preclust() Pre-compute measures on which to cluster components from study 'N400STUDY' Select the cluster to refine during sub-clustering (any existing sub-hierarchy will be overwritten) ParentCluster 1 (151 ICs)											
Γ	Pre	-compute or Load spectra	Dim	s.	Norm. Rel.	wt. Frequency range [Hz]	3 25				
	*	ERPs dipoles	10 3	•	1 10	Latency range in ms [lo hi]	-2100 1995				
	×	scalp maps ERSPs	10 10		1	Use channel values 😐 Time/freq. parameters	 Absolute values a), [3 25], 'cycles', [3 0.5], 'pa 				
	*				1 Time/ileg pareneters		r), [3-26], it yeles (; [3-0-5], fp.				
	2	Save STUDY to file			/tiətə/cou	mon4/ama/Ssubjects/N400precluststudy					
	Cancel					Help	Ok				

N. Bigdely-Shamlo, 2010

IC Clustering: Affinity Clustering

and the provide a start of the second and the secon



(EEGLAB plug-in by Nima Bigdely Shamlo) only has one pre-clustering parameter.

1	Measure Product cluster	ing po	op_mpc	luster()	_ D X
	Number of clusters to comput Relative dipole weight (betwee Select measuretures to be use		10 0.8		
	♥ Dipo ♥ ERP ERSP ITC ♥ Spec Scalp				
	□Separate outliers (enter std.)		3	
	Help		Cance		<u>Dk</u>

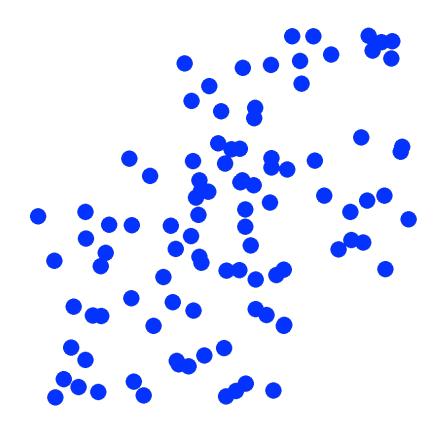
N. Bigdely-Shamlo, 2010

Problems with multi-measure clustering



In a uniform density distribution,

where are the clusters by location?

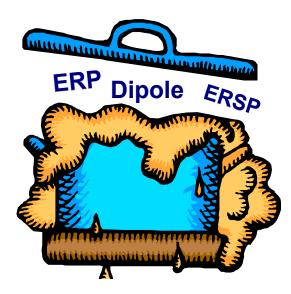


Study IC Clustering: New Approach

half and a second and a second and a second and a second of the second and and a second and the second of the second and the second and



- With either clustering method, we basically mix together distances for a subset of EEG measures (ERP, ERSP, ITC, mean spectrum, dipole location).
- This may make clustering distance less interpretable.

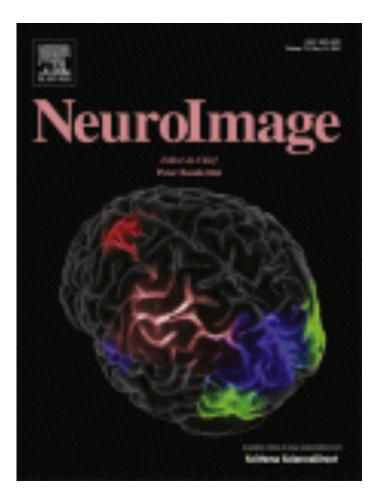


Study IC Clustering: Measure Projection

- Swantz Center for Computational Neuroscience
- Instead, we can directly work on pair-wise similarity matrices and prevent ICs with similarities less than certain threshold (e.g., ERSP corr. < 0.5) to be clustered together.
- The most important measure is **equivalent dipole location**.
- Assuming a certain variability estimate for dipole location (due to error in localization and subject variability), one can also estimate an optimum number of clusters.

Measure Projection





EEGLAB Workshop 16, June, 2013, Aspet, France: Scott Makeig – Component Clustering

Measure Projection: RSVP Example



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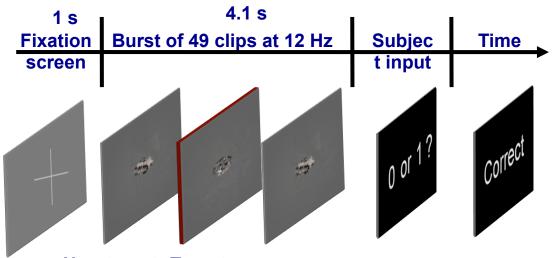




Rapid Serial Visual Presentation Experiment

•8 subjects •15 Sessions •Visual target detection

•257 components with equiv. dipoles inside the brain

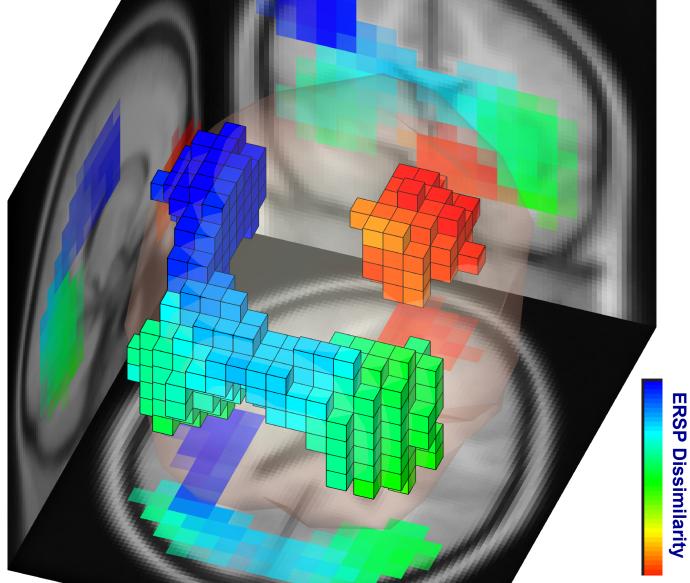


Non-target Target Non-target

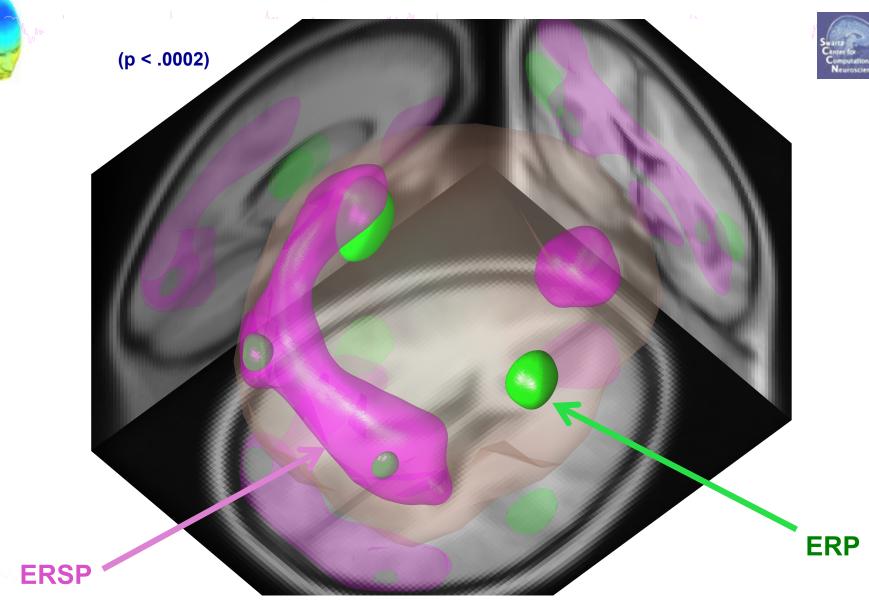
Measure Projection: RSVP Example

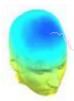
Project Target ERSPs on Equivalent Dipole Locations





Measure Projection: RSVP Example





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Questions?



30